Engineering

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MODERN ENGINEERING MAY be assumed to have begun in the latter part of the seventeenth century. One influential factor was the founding of the Royal Society of London in 1660 to promote the application of physics and mathematics; another was the organization of the *Académie des Sciences* of the *Institut de France* in 1666. From the establishment of these organizations, which were largely scientific in character, and with the rise of schools of applied science, has come the art of engineering. Engineering emphasizes the creation of structures, machines and devices, but it is dependent on science. Chemistry is basic to the production and utilization of the fuels that drive our automobiles and space vehicles, as well as to metallurgy and sanitary engineering. The science of astronomy is basic to the control and operation of space vehicles, and it is also basic to geodetic engineering. Mining and civil engineers need the science of geology in many aspects of their work. Mathematics and physics cut across most areas of engineering.

From the above it is clear that engineers must use the bibliographical services of science. Of these, some major ones frequently used in the Engineering Societies Library are: *Physics Abstracts* (London, 1903–); *Chemical Abstracts* (Easton, Pa., 1907–); *Nuclear Science Abstracts* (Oak Ridge, Tenn., 1948-); *Physikalische Berichte* (Brunswick, Germany, 1920-); *Bibliography of North American Geology* (Washington, D.C., 1919–28–); *Bibliography and Index of Geology Exclusive of North America* (Washington, D.C., 1933–); and although now less used than formerly the still important Royal Society of London's nineteen volume *Catalogue of Scientific Papers, 1800-1900* (London, C. J. Clay and Sons, 1867-1902; Cambridge, Cambridge University Press, 1914–1925) which is arranged by author. In the incomplete subject index, subsequently published, articles with engi-

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neering content are classified under the most closely applicable subdivision of science.

General Engineering Services. Engineering developed from science and has never gotten away from it, though there was a period when engineers seemed intent on emphasizing their independence from science. There was heavy dependence on pocket books and handbooks, and upon engineering books and journals which strongly emphasized applications. Now engineers and scientists are again working together even more closely. Some of the more recent bibliographical services recognize and give emphasis to the trend. One example is the *Abstracts of Photographic Science and Engineering Literature,* published in New York since 1962 under the auspices of the Society of Photographic Scientists and Engineers.

The *Referativnyi Zhurnal* published by the Akademiia Nauk SSSR in Moscow is probably the world's largest indexing and abstracting service, cutting across all of science and technology. It is issued in over fifty subject sections, e.g. astronomy, physics, mining, machine building, paper, and printing; and some of these sections are available in further subdivisions. All items are classified by the Universal Decimal Classification (UDC) system.

There are some abstracting and indexing services which are primarily in the field of engineering or which are largely devoted to applied science, of which a considerable portion is engineering. Of these, *The Engineering Index,* the oldest and most extensive abstracting service for engineers, has been published in New York and London under various ownerships continuously since 1884. Its original and continuing major form is the annual compilation in book form, which for 1965 totaled 2,712 pages of tightly-packed bibliographical information and abstracts. Also included is a 137-page author index.

In 1928 *The Engineering Index* began offering its service in card form. The cards provide the same subject headings, bibliographic information and abstracts as does the annual volume. This service is available in 286 subject divisions. Subscriptions may be entered for one, or several divisions supplied weekly, or for the entire card service on a daily basis. Most subscribers to the card service are now individuals or companies with limited subject interests. October 1962 saw the establishment of the monthly *Bulletin* of *The Engineering Index,* which is identical in content and format with the annual volume of *The Engineering Index.* Since the advent of the monthly service some

subscribers to several divisions or to the entire card service have switched to the *Bulletin.*

Because of various factors such as frequency of publication, cost and convenience of service, there is no clear-cut trend discernible in the demand for the various forms of these services. Strictly on the basis of the number of subscribers to the card service versus the monthly *Bulletin* and the annual volumes of *The Engineering Index,* it appears that more are interested in the complete services than in the selective approach of the card service.

Two sections of *The Engineering Index,* one titled "Plastics" and the other "Electrical/Electronics," were started on a pilot basis in 1965. Each is published monthly in bulletin form. The main sections of each contain bibliographic information and abstracts grouped in moderate-sized subject subdivisions, not under subject headings and subheadings as in the basic *Engineering Index.* Author indexes are included in the industrial and library editions (but not in the very low-priced editions for individual engineers) of the sections on "Plastics" and "Electrical/Electronics" engineering. The major departure from the conventional *Engineering Index* in the pilot sections is in the subject indexes. These are based on the terminology in the *Thesaurus of Engineering Terms* published by the Engineers Joint Council (EJC).[1] (A second edition is in preparation.)

It should be of value briefly to report here on the planning and work of the Engineers Joint Council in regard to engineering information. In January 1962 the Engineers Joint Council held a symposium to announce the EJC Action Plan for improved dissemination of engineering information. The *Proceedings* [2] of this symposium describe mechanized information services, discuss the need for cooperation among engineering societies in dealing with the information problem, and outline a plan for preparing an engineering thesaurus. Plans also call for source publication of abstracts together with indexing terms from the thesaurus for retrieving technical information. The system proposed to be developed from these basic actions, envisaged the use of roles and links in a coordinate indexing system. Of the several papers relating to the EJC information plans, one by Holm [3] and another by Klein [4] are especially useful. EJC held a second symposium in 1965, the Proceedings of which were published in 1966.

Now to return to pilot sections of the *Engineering Index.* It was previously indicated that the subject indexes of the published version of this are based on the terminology in the *Thesaurus of Engineering*

Terms, but some modification was required for publication, and some additional terms were found to be necessary when actual indexing of the existing engineering literature was undertaken.

In the published subject indexes of the pilot sections, there is an average of four index entries for each item. At the same time that the published sections are produced, deeper indexing to the extent of about twelve subject terms per item is put into a computer memory so that it may be used for retrospective literature searching and for a selective dissemination of information (SDI) service.

The American Society for Metals, through its documentation service, has been working closely with *The Engineering Index* and the Engineers Joint Council. The terms used in the subject index to the *ASM Review of Metal Literature* (Metals Park, Ohio, 1944–) are taken from a thesaurus developed by ASM, but its structure is basically that of the EJC *Thesaurus of Engineering Terms.*

Examples of other services using relatively comparable systems are the alternately issued *Scientific and Technical Aerospace Reports* (STAR) published by NASA (which includes government reports), and the *International Aerospace Abstracts* published since 1961 with the cooperation of NASA by the American Institute of Aeronautics and Astronautics. The latter covers the published literature on aerospace subjects. The indexes of both are produced with the aid of a computer.

U.S. Government Research & Development Reports (Springfield, Va., 1946–) now issued by the U.S. Clearinghouse for Federal Scientific and Technical Information provides abstracts of reports released by Department of Defense as well as by other government and civilian agencies.

Nuclear Science Abstracts, published by the Atomic Energy Commission, covers both government reports and other literature in its field.

Applied Mechanics Reviews (Easton, Pa., Jan. 1948–) provides a computer-produced annual subject index, and also a separate annual index known as *WADEX* which includes authors and words from titles used as subject approaches in an interesting modification of the keyword-in-context (KWIC) system conceived and developed by H. P. Luhn. It is notable that *Applied Mechanics Reviews* publishes critical abstracts, a relatively rare and valuable type, which must be produced by subject experts. The chief drawback is that critical abstracts take longer to produce and their publication is delayed.

Electrical and Electronics Abstracts, Series B of *Science Abstracts*

(formerly *Electrical Engineering Abstracts,* 1903–) is issued by the Institution of Electrical Engineers in London. Arranged by subject groups and with UDC numbers assigned to each article, this standard abstracting service has a conventional subject index as well as an author index. Its readability is high compared to some of the computer-produced ones. It is encouraging to note, however, that some of the services produced by computer have recently improved in readability.

Most of the services used by engineers contain abstracts. There is continual demand that the abstracts be improved and that they be published more promptly. Up to now these two aspects have been largely incompatible. Perhaps the computer will help to some extent, but good abstracts are produced by knowledgeable persons having special skills as abstractors. Such persons are scarce and also often busy with other work, so there is delay. Authors and editors are being encouraged to include abstracts with each article. This can help to speed up abstracting services and reduce their costs, but only at the risk of not having abstracts that are slanted toward the specific subject interests of the users of the abstracting service.

Some services provide no abstracts. One in wide use is *Applied Science and Technology Index,* produced in New York by the H. W. Wilson Company (1958–). *British Technology Index* (London, 1962–) is a relative newcomer. At the Engineering Societies Library it is valued chiefly for its coverage of British publications not elsewhere indexed. However, the way in which its very extensive cross-reference structure is presented is more disturbing than helpful.

No doubt it is already clear that the writer has no intention of producing a comprehensive list of bibliographical services, but rather of citing some which are frequently used or which are examples of some type or have some special characteristic. Those already referred to are generally extensive services, both in scope and in the period of time they cover.

Specialized Engineering Services. Many very specialized services have recently started publication. Usually each of these represents a restricted field, and the coverage is often quite limited, as is their readership; but obviously such services are important or their number would not have expanded as it has. The following list of these is far from complete and is in no particular order, but it is extensive enough to give some indication of the diversity of these services:

Solid State Abstracts, Cambridge, Mass., 1960– .
International Bibliography of Automatic Control, Brussels, 1962– .
Electroanalytical Abstracts, Basel, 1963– .
Corrosion Abstracts, Houston, Tex., 1962– .
Copper Abstracts, London, 1959– .
Abstracts of Photographic Science and Engineering Literature, New York, 1962– .
International Abstracts in Operations Research, Cambridge, Mass., 1961– .
Gas Chromatography Abstracts, Chicago, 1958– .

There appears to be a trend toward other specialized services, some sponsored from within the private sector of the economy but more from information centers sponsored by government agencies. Because of government emphasis on information centers [5, 6] it seems likely that this will be a growing field. Some examples of the types of publications from information centers are:

Battelle Memorial Institute, Columbus, Ohio. Defense Metals Information Center. *DMIC Selected Accessions List.*
Colorado School of Mines Research Foundation, Inc., Golden. *Mineral Industries Bulletin,* 1958– .
Purdue University. Thermophysical Properties Research Center. *Data Books.* Lafayette, Ind., [1961–66].
Retrieval Guide to Thermophysical Properties Research Literature, New York, 1960–[1964].
U.S. Department of the Air Force. Office of Aerospace Research. *OAR Cumulative Index of Research Results,* 1956– .

There is a growing trend toward directly supplying specific data or information on demand to those whose relationship, work, or support qualifies them for receipt of such service. Sometimes references may be given, but often factual information is supplied in lieu of references. Examples of organizations providing this type of service include:

U.S. National Bureau of Standards.
Atomic Transition Probabilities Data Center, Washington, D.C.
Boulder Laboratories Library, Boulder, Colorado.
Cryogenic Data Center, Boulder, Colorado.

U.S. Department of the Air Force.
Air Force Materials Laboratory, Wright-Patterson Air Force Base, Ohio.

Still another variant does not provide bibliographic references to published literature, but instead provides reference to ongoing research, thus providing the engineer with earlier knowledge of new work and making it possible for him to talk to the researcher prior to any publication. Engineers especially like this way of getting new information. This type of service is available from, for example:

U.S. National Bureau of Standards. Mechanics Division, Washington, D.C. *Hydraulic Research in the United States.*

U.S. Department of the Air Force. Office of Aerospace Research, Washington, D.C. *OAR Research Review.*

U.S. Department of the Navy. U.S. National Oceanographic Data Center, Washington, D.C. *Newsletter.*

These information center publications and services were selected from *A Directory of Information Resources in the United States; Physical Sciences, Biological Sciences, Engineering.*[7]

Societies have increased the number of their meetings and symposia to such an extent that there is difficulty in knowing when and where the proceedings of the meeting have been published. This is especially true of those which are issued, often serially, as papers in periodical publications, and those published for societies by commercial publishers. Some of these are given titles which do not indicate that they are the proceedings of a meeting. Another problem is that some symposia are sponsored by several organizations. The need to identify publications resulting from these has led to the recent establishment of publications such as *Proceedings in Print* issued by Proceedings in Print (Mattapan, Mass., 1964–) and also the *Directory of Published Proceedings*, published by InterDok, White Plains, N.Y., 1965– .

Engineers tend to emphasize the use of recent publications and so make more use of journals, proceedings, specifications, trade catalogs, etc. than they do of books. These have not, however, been overlooked.

The Engineers' Council for Professional Development has issued, on an irregular basis, bibliographies of books on various engineering subjects, under the general title *Selected Bibliography of Engineering Subjects:*[8]

I. Mathematics, Mechanics & Physics (1962)
II. Aeronautical Engineering (1950)

III. Civil Engineering (1962)
IV. Ceramic Engineering (1965)
V. Metallurgical, Mining, and Geological Engineering (1962)
VI. Mechanical Engineering (1955)
VII. Electrical Engineering (1958)
VIII. Chemical Engineering (1962)
IX. Industrial Engineering (1962)

Services Provided by Libraries. The Engineering Societies Library in New York was organized in 1913 to merge and to operate as a unit the libraries of four engineering societies. These were sizeable and long-established collections of engineering literature. From this base the Engineering Societies Library has grown with the profession and now is the library of twelve engineering societies. It has a collection of 190,000 selected volumes covering all fields of engineering, primarily on the level of the graduate and practicing engineer. Now the books, reports, and sets of serial publications in the Engineering Societies Library are covered in the *Classed Subject Catalog*[9] and its index published in a basic set of thirteen volumes, plus supplementary volumes covering additions made in each year.

The Engineering Societies Library provides analytic entries in the 016 section of its *Classed Subject Catalog* for bibliographies, lists of references, bibliographical footnotes, etc., in books, bulletins, reports, proceedings, and other publications; and, of course, there are entries for complete bibliographies. References to bibliographies in the catalog now number about 15,000. A check of items in this section of the catalog provides a good starting place for a literature search.

In contrast to the extensive catalog of the holdings of the Engineering Societies Library, there is *A Selective Bibliography in Science and Engineering.*[10]

New Technical Books (1915–) published by the New York Public Library, and *Technical Book Review Index* (New York, 1935–) published by the Special Libraries Association include review and bibliographic information on recent engineering books.

The Engineering Societies Library reviews about one hundred new engineering books each month. The brief descriptive reviews are made available to editors of the journals of the societies with which the Library is related. Without giving a full list, it may be noted that *Civil Engineering* (New York, American Society of Civil Engineers, 1930–), *Mechanical Engineering* (New York, American Society

of Mechanical Engineers, 1906–), *IEEE Spectrum* (New York, Institute of Electrical and Electronics Engineers, 1964–), *Mining Engineering* (New York, American Institute of Mining, Metallurgical and Petroleum Engineers, Mining Branch, 1949–), *Illuminating Engineering*, (New York, 1906–), and *ASHRAE Journal* (New York, American Society of Heating, Refrigerating and Air-Conditioning Engineers, 1959–) publish selected reviews in their fields of interest prepared by the staff of the Engineering Societies Library.

The American Society of Mechanical Engineers and the Engineering Societies Library recently have cooperated to produce and issue a loose-leaf *Catalog of Motion Pictures of Research Data on Fluid Mechanics*.[11] This lists specialized research films collected and housed in the Engineering Societies Library with the aid of National Science Foundation funds. This catalog and collection is unusual in several respects. The films record research data. They were not produced for sale or promotion. Formerly such films were often lost, misplaced, or discarded as the individuals responsible for the research changed positions. The collection has resulted from wide solicitation to locate and acquire the films, and to provide for continuity in their maintenance. The catalog provides an abstract, a description, and a scene by scene outline for each film. Altogether this provides what has been called a "publication channel" for the films. Consideration is now being given to extending the collection to include research films in related fields.

The catalog also lists teaching films in the same subject area. These films are not collected and housed at the Engineering Societies Library as they are available from other sources that provide continuity of maintenance.

Guides to Literature. Guides to the literature of engineering are relatively few in number and none has achieved the acceptance accorded to some of those in chemistry of which outstanding examples are those by Crane, Patterson and Marr,[12] and Mellon.[13] Presumably this is due to the emphasis placed on teaching chemists to use the literature of chemistry, whereas, engineering curricula have been notably deficient in training engineers in the literature of engineering.

Gertrude Schutze has included guides to engineering in her *Bibliography of Guides to the S-T-M- Literature: Scientific, Technical, Medical.*[14] Of the individual guides to the engineering literature an early one was by Dalton.[15] More recent ones have been prepared by

Shank,[16] Johnson,[17] and Jenkins.[18] This last includes fields of science seldom if ever used by engineers.

In addition to the above general type of guide there are others covering certain subject areas, *e.g., a Guide to Information Sources in Space Science and Technology* [19] and *A Guide to Information Sources in Mining, Minerals, and Geosciences.*[20]

Conclusion. Those who read "New Concepts in Indexing" by Russell Shank [21] may observe that the trends noted and the conclusions reached in that article and in this one are similar. Yet, significantly, Shank's article is in part based on the medical field, although it cites many examples from science and engineering. It also comments more extensively on automation and equipment.

Among trends in engineering bibliography which are relatively clearly defined one should note the increasing reliance of engineers on science bibliography, the growing number of specialized abstracting services covering relatively small and specific subject areas, the influence of government emphasis on information centers covering limited subject areas, and the tendency to expect to receive actual data or information rather than references.

When references are wanted, there is a desire that more informative abstracts be provided. Encouragement is being given to authors and/or editors to publish an abstract and index terms with each article. Note should also be taken of the use of thesaurus-controlled terminology for indexing, the use of combined manual and mechanical methods of information handling, and of increased emphasis on the use of coordinate indexing. Coordinate indexing is adaptable for use by computers, but has not been proven desirable for published bibliographies or for card catalogs.

The use of mechanical devices will continue to grow. Computers have great speed and flexibility for manipulation, but to date they have shown poor adaptability in replacing the extensive intellectual aspects of information handling. Through the use of combined manual and machine methods, better services are being produced which can be used where the engineer works. User studies show that engineers, and scientists too, use nearby information sources in preference to those at a distance. Will this change as national information systems are established?

Planning for future bibliographic and information services for engineers is receiving extensive and coordinated attention by organizations

in the engineering profession. Foremost in consideration is the possibility of developing an engineering information system on a nationwide basis. Planning is being coordinated with that of government, industry, educational institutions and others. Those representing the engineering profession in the planning are aware of the cost of existing national systems such as those of NASA and the National Library of Medicine, and know that those automated national systems now operating are government supported. They recognize that the cost of extensive and well-automated systems is high and that government assistance may be required for an engineering system; nevertheless, the engineering profession is trying to plan a system and its organization so that the private sector of the economy will bear much of the cost.

The pressures of our growing literature could be substantially alleviated by publication of many and frequently updated state-of-the-art reviews providing adequate references to the literature. Good reviews are difficult to secure, for they must be prepared by well-informed men who are often too busy to take the required time. Specialized information centers are doing state-of-the-art work, but too little of that is published, and there are not enough centers to meet the obvious needs. It is to be hoped that engineering societies will foster such publications, and that their value will be so recognized that financial support will be adequate to make the work attractive to qualified men. Good technical libraries should have a part in this. It will take better financing, and more and better staff than some of them have now, but it should come about, for adequate state-of-the-art reviews would help meet our growing literature problem.

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